THE TOLLY GROUP

No. 204116 March 2004

Engim, Inc.

EN-3000 Multi-Channel Wireless Chipset

802.11b/g Throughput Evaluation

1989 - 2004 15 Years TOLLY

Test Summary

Premise: *Existing single-channel WLAN chipsets, such as those prevalent in commercially available access point products today, are performance-constrained by clients communicating at low data rates and the fact that they allow for operation on only a single channel. Engim's multi-channel wireless chipset provides more aggregate capacity as well as dynamic optimization of WLAN communication resulting in dramatically higher aggregate access-point throughput.*

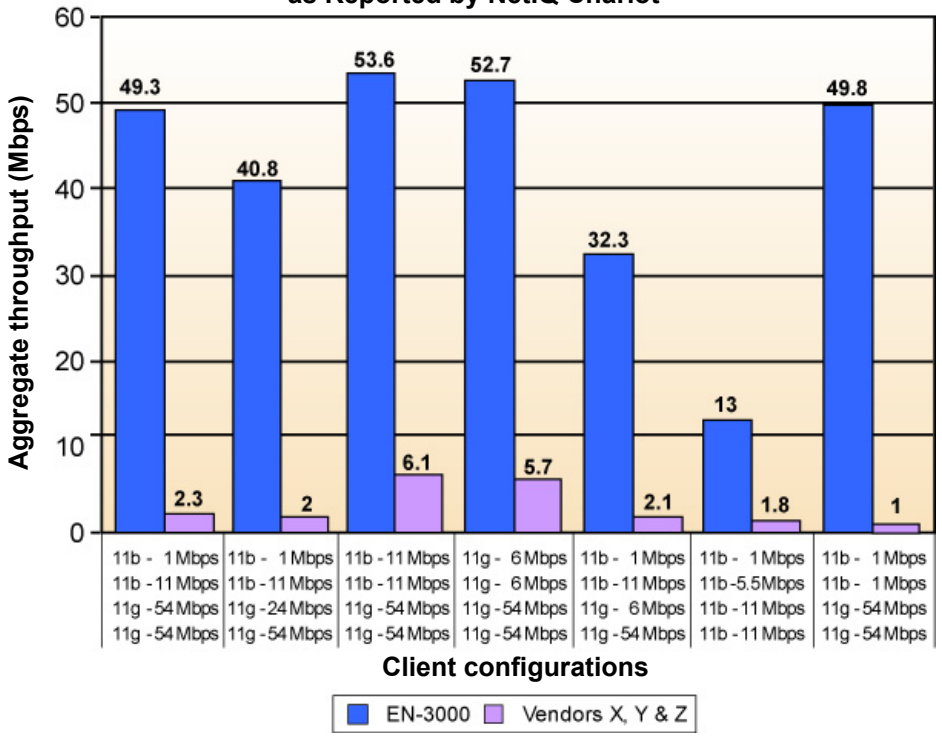
Engim, Inc. commissioned The Tolly Group to evaluate its EN-3000 multi-channel, wireless chipset's aggregate 802.11b/g throughput in a reference platform against three commercially available, single-channel enterprise-class 802.11g access points.

Eight different throughput test permutations were utilized to verify that performance differences are consistent across an array of connection types. To minimize the impact of RF anomalies and environmental noise, encourage repeatability, and focus on optimal throughput, engineers connected wireless LAN clients to each access point tested over a wired RF link. Attenuation was introduced to some or all of the clients to reflect real-world conditions. Multiple permutations of the tests were run, each having a differ-

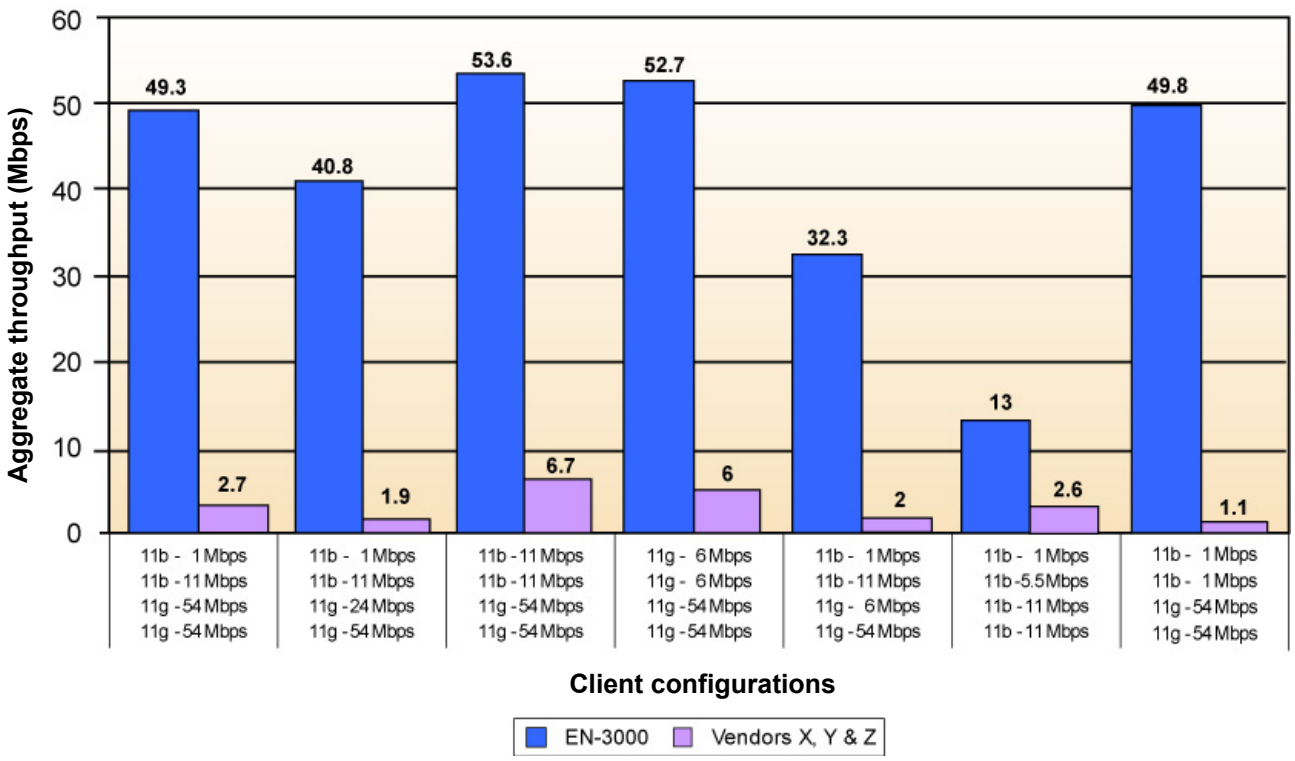
Test Highlights

- Delivers up to 50 times greater aggregate TCP throughput than single-channel wireless access points supporting mix of 802.11b and 802.11g clients
- Delivers almost 50 times greater aggregate UDP throughput than single-channel wireless access points supporting mix of 802.11b and 802.11g clients
- Delivers aggregate UDP throughput of almost 80 Mbps and TCP throughput in excess of 70 Mbps

Aggregate Throughput of Access Points with Four Clients of Mixed Standard and Association Rates using TCP
as Reported by NetIQ Chariot



Source: The Tolly Group, January 2004 *Figure 1*



Source: The Tolly Group, January 2004

Figure 2

ent set of standard and association rates for the clients.

Because the focus of this report is to illustrate the benefits of one technology over another, the commercially available single-channel access points are identified only as "X," "Y," and "Z." Three different leading enterprise-class access points were chosen to illustrate that this is not a limitation associated with just a single leading AP brand.

Results show that the AP based on multi-channel Engim technology delivers consistently higher performance than any of the three commercially-available single-channel APs tested. In every scenario, the Engim results are at least three times greater than the other AP results. In most scenarios, Engim results are 10 to 20 times greater and, in several tests, approximately 50 times greater than the other products' results. Tests were conducted in January 2004.

Results

The Tolly Group measured the aggregate throughput of the APs under test, using eight throughput test scenarios that included: all 802.11g users, some at maximum data rate and some at the minimum rate; all 802.11b users, evenly distributed; all 802.11g users at the maximum data rate and various permutations of a mix of 802.11b/g users with variable levels of maximum and minimum data rates.

In one scenario, with two clients operating at the maximum 802.11g 54 Mbps rate, one 802.11b client operating at the maximum 11 Mbps and another 802.11b client at 1 Mbps, the EN-3000-based reference platform delivered an average aggregate throughput of 49.3 Mbps — or 17 times greater throughput than that of the next nearest single-channel AP.

This throughput gap played out in every test scenario, widening further in some cases, and narrowing slightly in others. The greatest throughput disparity was seen in a scenario with two 802.11g clients transmitting at 54 Mbps and two 802.11b clients transmitting at 1 Mbps. The EN-3000-based reference platform delivered right around

50 Mbps of throughput, versus about 1 Mbps, on average, for each of the three single-channel APs.

In a scenario with four 802.11g clients, two transmitting at 54 Mbps and two at 6 Mbps, the single-channel APs improved to about 6 Mbps while the Engim reference platform improved to almost 53 Mbps.

Even in tests with UDP traffic, the Engim reference platform outperformed the throughput of the single-channel devices consistently. In a scenario with two 802.11g clients running at 54 Mbps each, one 802.11b client running at 11 Mbps and another 802.11b client at 1 Mbps, the EN-3000 reference platform delivered 20 times the throughput of single-channel APs tested.

In another maximum aggregate throughput test of three 802.11g clients transmitting at the maximum rate, throughput for the EN-3000 was 72.4 Mbps for TCP traffic and 78.7 Mbps for UDP traffic versus 24 Mbps and 29 Mbps respectively for the nearest single-channel AP. That equates to a 66% and 63% performance hike of the tri-channel EN-3000 over the single-channel APs.

Analysis

Since the Engim EN-3000 chipset uses three channels, whereas virtually all other commercially available chipsets use one channel, one might expect that the aggregate throughput from the access point reference platform based on Engim technology would offer at least three times the capacity of other vendors' products. This was the case in all scenarios tested. The presence of lower rate stations (802.11b) and 802.11g stations associating at lower data rates (as will likely occur in actual use) severely degrades the overall performance of single-channel devices. These real-world scenarios were Engim's driving factor in creating the multi-channel wireless AP chipset.

In enterprises, wireless clients connect at different data rates. This is because wireless clients can be a mix of 802.11b and 802.11g WLAN standards, and because clients reduce their communication rate as they move farther from the AP. Packets from clients that are communicating at a low rate relatively take more time to transmit. These packets tend to dominate the channel, preventing many of the faster packets from getting through. With a single-channel access point, all the packets have to share the same channel. However, a three-channel AP solution allows clients communicating at slower speeds to be clustered onto a single channel, leaving the remaining channels available for the faster clients. When this capability is combined with the ability to dynamically move clients from one channel to another based on their connection speed and on the load on a particular channel, a speedup can be achieved that is far greater than the three times increase one might expect from three channels.

The Engim AP offers this capability, providing three tightly

Engim, Inc.

EN-3000 Multi-Channel Wireless Chipset

Aggregate TCP/UDP Throughput Evaluation

Engim, Inc.
EN-3000 Multi-Channel WLAN Chipset
Product Specifications*

- Support for three channels of simultaneous 802.11 WLAN operation enables unprecedented access point capacity
- Highly integrated chip set employs unique wideband spectral processing technology to mitigate RF interference and continually monitor the complete RF spectrum
- RF Spectrum Monitor continually monitors active and inactive channels for intrusion detection and optimal channel selection without disrupting WLAN traffic flow
- Hardware-based security support features onboard security engine for support of AES, WEP and TKIP to ensure line-rate secure communications and 802.11i compliance
- Dynamic Frequency Selection and granular Transmit Power Control for maximum network control and scalability
- Standards-based technology supports multi-channel IEEE 802.11a/b/g operation and 802.11 extensions including 802.11e and 802.11i draft standards. Designed for Wi-Fi and WPA compliance
- Programmable MAC design allows granular control of all MAC parameters for maximum configuration flexibility. MAC Bypass mode available to enable the use of 3rd party MAC solutions

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**Vendor-supplied information not verified by the Tolly Group*

Aggregate Throughput of Access Points with Four Clients of Mixed Standard and Association Rates using TCP
as Reported by NetIQ Chariot

Access point tested	Iteration	Client Configurations						
		1	2	3	4	5	6	7
		11g - 54Mbps 11g - 54Mbps 11b - 11Mbps 11b - 1Mbps	11g - 54Mbps 11g - 24Mbps 11b - 11Mbps 11b - 1Mbps	11g - 54Mbps 11g - 54Mbps 11b - 11Mbps 11b - 11Mbps	11g - 54Mbps 11g - 54Mbps 11g - 6Mbps 11g - 6Mbps	11g - 54Mbps 11g - 6Mbps 11b - 11Mbps 11b - 1Mbps	11b - 11Mbps 11b - 11Mbps 11b -5.5Mbps 11b - 1Mbps	11g - 54Mbps 11g - 54Mbps 11b - 1Mbps 11b - 1Mbps
EN-3000	1	50.4	40.7	53.7	52.0	32.0	13.1	50.3
	2	47.5	40.9	53.0	52.3	32.3	13.1	49.2
	3	50.0	40.9	54.0	53.9	32.5	13.0	49.9
	Avg.	49.3	40.8	53.6	52.7	32.3	13.0	49.8
Brand X	1	1.7	1.6	5.1	5.2	3.3	1.7	1.0
	2	2.7	3.2	5.2	5.9	2.9	1.6	1.0
	3	2.6	1.4	5.2	5.2	3.4	2.2	0.9
	Avg.	2.3	2.1	5.2	5.4	3.2	1.8	1.0
Brand Y	1	1.8	1.8	6.6	6.2	1.6	1.9	0.9
	2	1.8	1.8	6.7	6.2	1.5	1.9	1.0
	3	1.9	1.8	6.8	6.2	1.5	2.0	1.1
	Avg.	1.8	1.8	6.7	6.2	1.5	1.9	1.0
Brand Z	1	2.9	2.0	6.4	5.2	1.7	1.6	1.0
	2	2.8	2.0	6.6	5.3	1.5	1.6	1.1
	3	2.9	2.0	6.4	5.8	1.6	1.6	1.1
	Avg.	2.9	2.0	6.5	5.4	1.6	1.6	1.1

Source: The Tolly Group, January 2004 *Figure 3*

coupled channels combined with software that dynamically directs clients to best utilize the available resources.

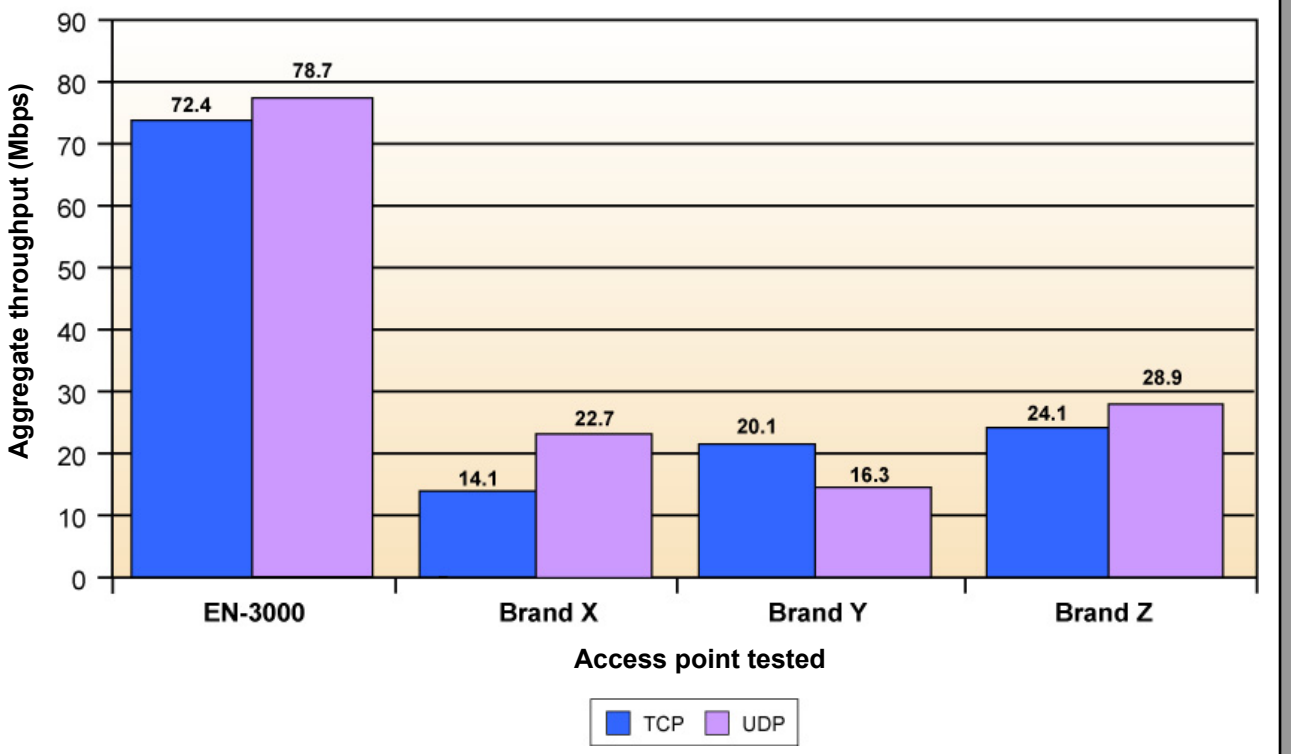
Test Configuration and Methodology

For performance tests, The Tolly Group tested an Engim, Inc. EN-3000 Multi-LAN Switching Engine for Wireless Access Points, software version 2.0.7.3, outfitted with a single 10/100 Fast Ethernet interface, three-channel wireless LAN and support for 802.11b/g clients. The reference platform is based upon a 400-MHz Intel IXP425 network processor with 32 Mbytes of

Maximum Aggregate Throughput of Access Points
Three 802.11g Clients at Max Data Rates as Reported by NetIQ Chariot

Access point tested	TCP	UDP
	11g - 54Mbps 11g - 54Mbps 11g - 54Mbps	11g - 54Mbps 11g - 54Mbps 11g - 54Mbps
EN-3000	72.4	78.7
Brand X	14.1	22.7
Brand Y	20.1	16.3
Brand Z	24.1	28.9

Source: The Tolly Group, January 2004 *Figure 4*



Source: The Tolly Group, January 2004

Figure 5

memory and running Linux as the operating system.

To demonstrate the performance of the enterprise access points in environments in which 802.11b and 802.11g clients co-exist, and where not every client is connected at maximum data rates, a variety of client configurations were used.

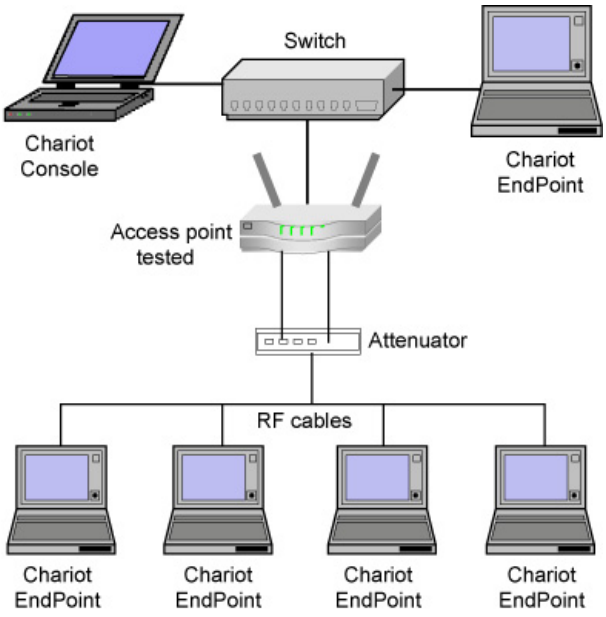
Four clients were used for each test permutation. For each of these tests, the wireless clients were either of the 802.11b or the 802.11g wireless network standard, and were set to different association rates. The clients were a mix of Dell Computer Corp. Inspiron 4000 and Inspiron 2650 PCs, each with memory ranging from 128MB to 512MB, and all of them running Windows 2000 Professional Version 5.0.2195 Service Pack 3, Build 2195.

The clients were connected to the APs by wired RF connections to minimize the impact of RF anomalies and environmental noise. Each client was connected to a combiner via RF cables and an attenuator. The combiner was then connected to the AP's antenna interfaces via RF cables.

A switch was connected to the AP under test via its Ethernet port. It was also connected to a PC running Chariot Endpoint 4.5 and a system running Chariot Console 4.3. Each wireless client was also running Chariot Endpoint 4.5. The Chariot Console created traffic and measured the aggregate throughput from the wireless clients to the wired PC running the Chariot Endpoint.

For the aggregate throughput test, the Chariot Console was configured to create one stream for each client with TCP traffic to be transmitted by the wireless client and received by the wired Endpoint. The traffic was generated for two minutes.

Engineers then repeated the test for a total of three iterations and averaged the throughput results. Following the TCP throughput test, engineers repeated the



Source: The Tolly Group, January 2004 *Figure 6*

process using UDP traffic. Eventually, the test was run for each of the APs tested and each of the different sets of client configurations (standard and association rates).

Blind Format

The purpose of this test was not to conduct a head-to-head competitive throughput benchmark, but rather to evaluate single-channel AP technology versus the multi-channel technology that underpins the EN-3000. For that reason, while The Tolly Group did compare the performance of the EN-3000 against three leading single-channel APs available on today's market, their identities are not disclosed because this is a technology evaluation, not a product benchmark.

The Tolly Group gratefully acknowledges the providers of test equipment used in this project.

Vendor	Product	Web address
NetIQ Corp.	Chariot Console V4.3	http://www.netiq.com
NetIQ Corp.	Chariot Endpoint V5.0	http://www.netiq.com

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Project Profile

Sponsor: Engim, Inc.

Document number: 204116

Product class: 802.11g/b Multi-channel Chipset

Products under test:

- EN-3000 Multi-LAN Switching Engine for Wireless Access Points

Testing window: January 2004

Software versions tested:

- SW Ver. 2.0.7.3.

For more information on this document, or other services offered by The Tolly Group, visit our World Wide Web site at http://www.tolly.com, send E-mail to sales@tolly.com, call (561) 391-5610.

The Tolly Group doc. 204116 rev. clk 09 Mar 2004